Draft Drill Plan

for Site Specific Hydrogeologic Characterization

Comanche Power Station

Public Service Company of Colorado

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1.0 Introduction

The purpose of this Drill Plan is to describe the installation, development, sampling, and testing of investigative borings and monitoring wells at Comanche Power Station (Site) located in Pueblo, Colorado. There are two CCR units at the site, an ash landfill and a bottom ash pond (BAP). Completion of additional geologic borings and installation of additional monitoring wells at Comanche will supplement the existing certified CCR groundwater monitoring network and results of the hydrogeologic investigation will support further definition of the conceptual site model in anticipation of submitting a Part B demonstration for the BAP under the U.S. Environmental Protection Agency Coal Combustion Residual (CCR) Rule.

HDR has retained Dakota Drilling to provide on-site drilling services. HDR will be responsible for oversight of Dakota Drilling activities. No drilling operations shall commence until all drilling personnel and geologists have completed site specific safety training. Additionally, daily safety briefs shall be conducted by the on-site project team prior to commencing work. The training and safety briefs shall be documented in accordance with HDR's *PSCo CCR Rule Compliance Health & Safety Plan.*

2.0 Proposed New Wells

There are approximately seven wells that are proposed at Comanche to further the understanding of the complex hydrogeology of the Site. The drilling approach will be a phased approach, taking observations from each well and applying findings to the approach and design of each following well.

The primary objectives are to:

- Further define the lateral extent of the isolated perched water to evaluate if there is a laterally continuous water table across the site and characterize the hydraulic gradient.
- Identify well locations that may be used for background water quality, if possible.
- Confirm whether all landfill monitoring wells are penetrated deep enough to intersect the potential water table.
- Confirm there is no off-site migration of CCR Rule constituents of interest utilizing an expanded monitoring well network at the facility boundary in the vicinity of the surface impoundment.
- Refine geologic cross sections based on findings.
- Utilize additional well borings using core drilling to allow for detailed hydrogeologic borehole logging that will more accurately define the uppermost groundwater, whether through primary porosity, low hydraulic conductivity material or potential flow along secondary porosity fractures. These new borings will add insight into the hydrogeologic conceptual site model. For example, there have been studies from prior consultants over the years with different drilling purposes and drilling methods, including geotechnical drilling and groundwater monitoring. It is not unusual that borehole logging may vary with

different drilling methods, especially notes associated with the potential for groundwater flow (e.g. moisture content, fractures, weathering, etc). Core drilling will improve understanding and potentially help to address inconsistencies in prior studies.

- Additional boreholes will allow for deeper drilling into the Pierre Shale, where appropriate, to evaluate the presence/absence of groundwater within the upper portions of the shale unit. Thus drilling will evaluate the depth of water, if present, and confirm presence above and/or below the consolidated bedrock contact. If this is better understood, each existing well can be evaluated to determine if they are screened in the appropriate location for consistent water quality monitoring across the site.

- Additional boreholes will allow for a view of how fractured or weathered the units are, which will also allow for evaluation of vertical migration.

2.1 Locations

Figure 1 provides the proposed location of the borings and potential monitoring wells at the Site.

2.2 Phased Approach

The drilling approach will be a phased approach, taking observations from each well and applying findings to the approach and design of each following well.

1. Drill W-2B

Results from all available site investigations have been incorporated into the site conceptual model and show that most locations on the property are dry and therefore it is difficult to locate a background well. Existing monitoring well W-2 is dry and appears to have a couple feet of sediment in the bottom based on the well log and recent monitoring events. It is appropriate to start at this location based on proximity to the BAP and that this well appears to have had intermittent groundwater in the past (e.g. dry on some occasions and a small amount of water in the well on a few occasions). This location, if groundwater is present, may serve as a background location for water chemistry. It is more effective to drill a new well than try to repair the existing well and will allow for updated geologic logging.

- ✓ Install a multi-level well, if feasible based on presence of groundwater above and below the bedrock contact. This will evaluate whether there is water in different geologic units/elevations and allow for comparison. It will also help inform whether existing monitoring well screens are appropriately placed relative to the water table and bedrock.

    - One well will be screened above the bedrock (bottom of screen at bedrock surface).

    - A second well will be screened below the bedrock if possible (~10-30 feet into the bedrock depending on the extent of fractures).

    - The incremental drilling approach described below is intended to provide parameters to consider (degree of fracturing, moisture, etc.) during drilling that will help inform the appropriate depth of the boring and whether or not it will be completed as a well. Additional detail regarding how each boring will be evaluated

is included in Section 3, Drilling and Well Development. An incremental approach will also allow flexibility for the study to evaluate vertical migration potential. The following is a general guideline and will be adjusted as needed based on findings in the field:

- If bedrock is fractured at the top of the bedrock – continue to drill deeper into bedrock until find very few to no fracture zone, or 100 feet whichever is first, and screen the fractured bedrock.

- If the bedrock has very few or no fractures (and looks dry) – drill ~20 feet into the bedrock to confirm, and do not install a well.

- For each scenario installation of a temporary well may be considered if the moisture content is not clear. The temporary well would remain in place for several days to hold the hole open and see if groundwater enters the well and to what elevation to determine appropriate screen depth. If it remains dry, PSCo will decide if they want a permanent well to continue to monitor a dry condition or abandon the borehole with the understanding that the location is dry.

2. Install Perimeter Wells

Two wells will be drilled along the east and southeast side to monitor for horizontal perched flow from the BAP area and potential offsite migration. These drill locations may also provide evidence of disconnected perched water across site with further distance from the ponds. If these wells are dry, they will be constructed to monitor if the condition remains dry.

One well will be drilled in the northwest corner of the property. This well location may serve as a background well if there is groundwater and to further understand the hydraulic gradient across the site or provide further evidence of disconnected perched water across site as a whole.

Each location may require installation of a temporary well if the moisture content is not clear. The temporary well would remain in place for several days to hold the hole open and see if groundwater enters the well and to what elevation in order to determine appropriate screen depth. If the eastern wells remain dry, they will still be constructed to monitor if the condition remains dry. If the northwest borehole remains dry, PSCo will determine if they want a permanent well to continue to monitor a dry condition, or abandon the borehole with the understanding that the location is dry.

All of these wells will be constructed based on the observed depth to uppermost groundwater and findings from W-2B (screen above/below bedrock versus across bedrock) and will follow the same incremental approach based on field observations.

3. Deepen MW-4, -1, -2 at the Landfill

- If W-2B and the perimeter wells all show no fracturing of the bedrock and dry bedrock – then likely no need to deepen these wells. PSCo will determine if drilling should proceed any deeper.

- If W-2B and perimeter wells show fracturing of the bedrock – then deepen these wells. These wells will be constructed based on the observed depth to uppermost

groundwater. Each site may require installation of a temporary well if the moisture content is not clear. The temporary well would remain in place for several days to hold the hole open and see if groundwater enters the well and to what elevation to determine appropriate screen depth. If it remains dry, PSCo will decide if they want a permanent well to continue to monitor a dry condition, or abandon the borehole with the understanding that the location is dry.

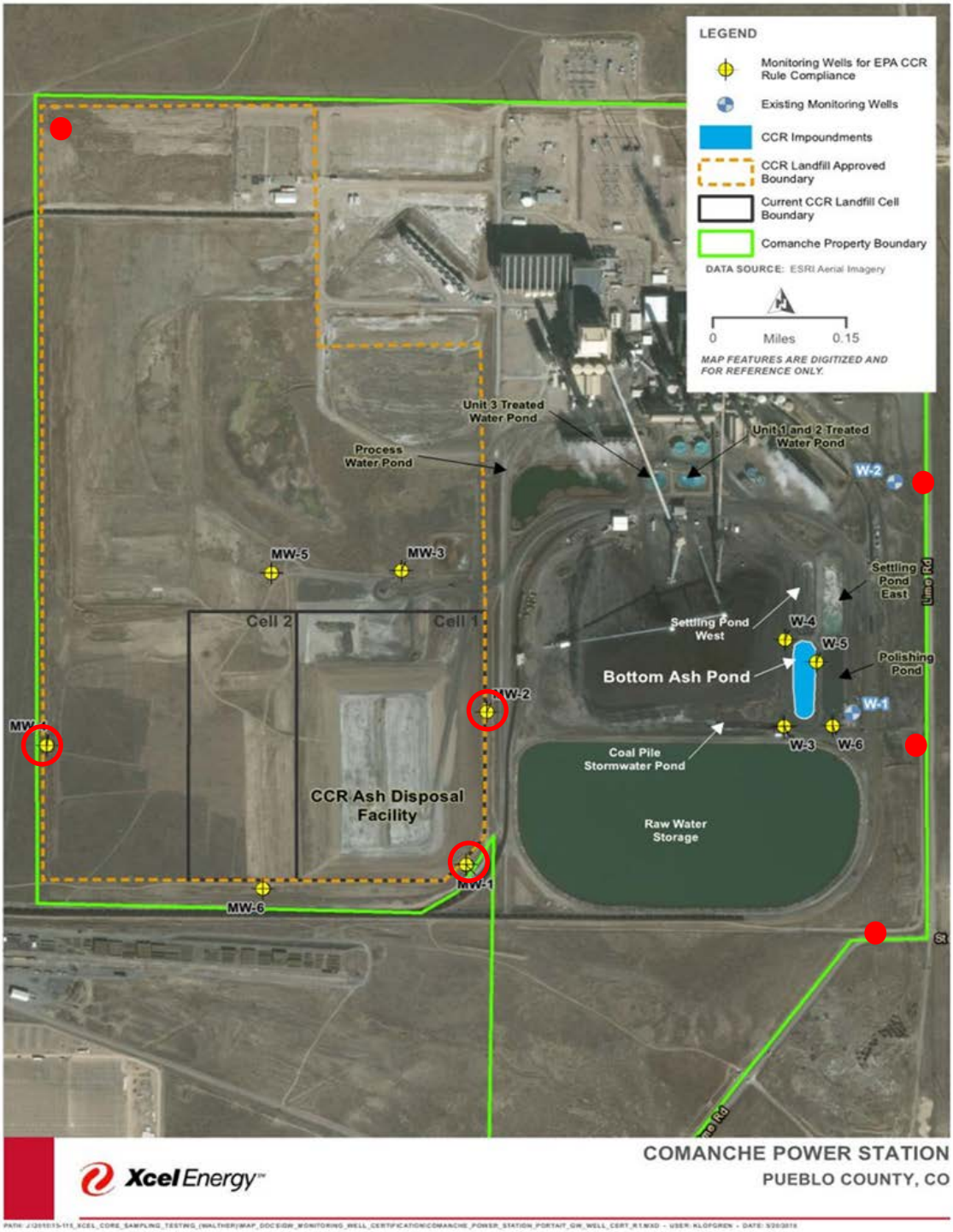

Figure 1. Proposed Well Location Map

3.0 Drilling and Well Development

3.1 Borehole Drilling

HDR shall coordinate the utility locates prior to drilling operations. Boreholes for each well will be drilled by the licensed well driller using a hollow stem auger through the colluvium and NX Core in the bedrock. A private utility locate will be performed using ground penetrating radar at each location. Drilling waste (cuttings and water) will be collected into 55 gallon drums by the drilling contractor. Wastes will be disposed by thin spreading and covering with fly ash in the on-site CCR landfill. The water source used to facilitate drilling will be provided by the Site.

3.2 Borehole Logging Procedures

Each borehole will be logged for lithologic characteristics by a geologist during drilling. An HDR field geologist will oversee and document the duration of well construction. Logging will include the following soil and lithologic characteristics, which generally follow standard guidelines for field logging (ASTM D5434):

- Soil type following the Unified Soil Classification System where appropriate,
- Grain size following American Society for Testing and Materials (ASTM) criteria for describing soils,
- Lithology and lithologic characteristics should be included to differentiate rocks of the same classification. These adjectives should be simple and easily understood, such as shaley, sandy, dolomitic, etc. Inclusions, nodules, and concretions should also be noted here.
- Weathering will be a visual notation:
    - Unweathered - no evidence of any mechanical or chemical alteration.
    - Slightly weathered - superficial discoloration, alteration, and/or discoloration along discontinuities; less than 10% of the rock volume is altered; strength is essentially unaffected.
    - Moderately weathered - discoloration is evident; surface is pitted and altered, with alterations penetrating well below rock surfaces; 10% to 50% of the rock is altered; strength is noticeably less than unweathered rock.
    - Highly weathered - entire section is discolored; alteration is greater than 50%; some areas of slightly weathered rock may still be present; some minerals are leached away; retains only a fraction of its original strength (wet strength is usually lower than dry strength).
- Consistency/relative density,
- Color using the Munsell Soil Color Chart (1992) and provide name and color code in parentheses,
- Cohesiveness and plasticity
- Moisture content will be a visual notation based on one of these conditions:
    - Dry - Absence of moisture, dusty, dry to the touch
    - Moist - Damp but no visible water

- Wet - Visible free water

Sample locations and other relevant information will also be noted on the Boring Log as well as in the Field Logbook.

For a sample core, the following information will also be recorded on the log:

- a scaled graphic sketch of the core breaks denoting the depth, location, orientation, and nature (natural or coring-induced) of all core breaks/fractures,
- coring information will be recorded in consecutively numbered runs and include the depth to top and bottom of each core run,
- the length of core recovered for each run, and
- the size and type of coring bit and barrel.

3.3 Sampling Procedures

Solid phase samples will be collected by the logging geologist. While drilling in colluvium above the bedrock, samples will be taken from material retrieved by the split spoon of the hollow-stem auger. The material will be labeled and placed in sealed sample bags or containers. If the water table and screen are within the colluvium, a two foot long Shelby tube (or similar) will be used to collect an undisturbed core of sediment from the depth below the water table coinciding with well screen location for laboratory analysis of hydraulic parameters. If the water table and screen are within bedrock and the coring is being completed, a California sampler will be used to collect the undisturbed sample. It may be determined that not all samples need to be analyzed by the laboratory. After drilling, it will be determined which samples to submit to the laboratory for analysis. Samples will be delivered to Yeh and Associates, Inc. geotechnical laboratory for the following tests:

- ✓ Permeability - ASTM D5084 Flexible Wall Permeability (undisturbed core or California sampler with caps)
- ✓ Moisture content - ASTM D2216 (sealed ziplock bag – at least 200 grams)

Laboratory analysis of hydraulic parameters (permeability) will be completed on the sample from each well at the depth below the water table coinciding with the well screen location. In order to ensure that each number for every field sample collected is unique, samples will be identified by the sample location and depth interval, if applicable (e.g., MW-11 (5-6')).

3.4 Well Construction

Each well will be constructed with 2-inch diameter, Schedule 40 PVC casing and screen. The screen for each well in the colluvium will be 10 feet long, if appropriate given the depth to water and the bedrock contact. Screens placed in a fractured bedrock may be 20 feet long, or longer, to capture more fractures in the screened interval. A 10-20 washed silica sand will be used for the filter pack and emplaced approximately 2 feet above the well screen. A 5-foot annular seal of coated bentonite pellets will be placed above the top of the filter pack and hydrated after placement. The remaining borehole annulus shall be filled to the surface with either high solids (>20% by dry weight) bentonite grout emplaced through a tremie pipe or with medium bentonite chips that were placed and hydrated in lifts. All wells shall be finished with a 2-ft x 2-ft concrete

pad. Each well shall include approximately 24 inches of PVC stick-up. Bollards will be installed at the direction of PSCo. Each well will be secured with a protective steel casing and lock. A log for each well will be prepared documenting well construction materials and depths.

3.5 Well Development

Well development will begin approximately 24 hours after well completion if the well has been grouted, or 12 hours after if the well has not been grouted and will consist of surging and purging the well. Development will cease when the water is clear and field parameters (pH, specific conductance and temperature) have stabilized. Stabilized field parameters are defined as three consecutive readings where temperatures are within 1°C, pH readings are within 0.2 standard units, and conductivity and turbidity values are within 10%. Most wells at Comanche purge dry quickly and recharge extremely slowly. Therefore it is expected that typical well development will not be possible. If this is the case, the well will be considered developed after being purged of 5 well casing volumes; field parameters will be monitored but need not be stabilized to consider the well developed.

3.6 Survey

Each well will be surveyed after completion. The survey will include elevations of the top of PVC casing (measuring point) and ground surface. The northing and easting coordinates of the wells will be surveyed.

3.7 Hydraulic Testing

The aquifer characteristics of each well will be determined with a slug test. Slug testing will be performed by HDR after the well has been fully developed. Most wells at Comanche purge dry quickly and recharge extremely slowly and thus slug testing has not been feasible in all wells at the site. If this remains the case and standard slug test cannot be performed, HDR will purge the wells dry and monitor the rate of recharge, similar to the existing data associated with monitoring well sampling (purge well dry and time the rate of recharge in the well using a water level meter rather than a transducer).

4.0 Documentation

HDR will complete the well permit registration for each of the new monitoring wells through the Colorado Division of Water Resources (CDWR).

The Well Installation Report for Comanche will be revised after the drilling and well construction activities are finished at the facility. The Well Installation Report will include the final well construction records including well construction details, lithologic descriptions, and survey information.